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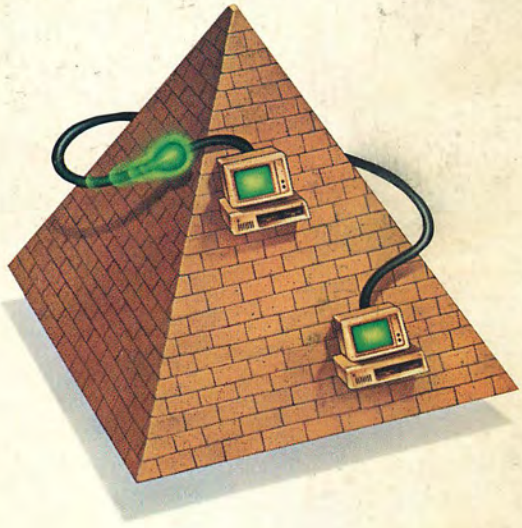
FOR IBM PERSONAL COMPUTER USERS

TECH JOURNAL

NESTAR'S PLAN 4000

The grandfather of local area networks for the PC



UPGRADING A PC TO AN "EXTRA T"

REAL TIME ANALYSIS OF SIMPLE DIGITAL LOGIC CIRCUITS

GUIDE TO USING THE IBM GAME ADAPTER

10 TIPS FOR IMPROVING DOCUMENTATION

PROLOK DISK AND SOFTWARE PIRACY

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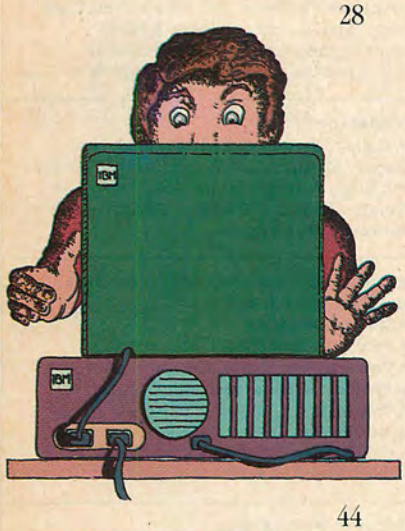

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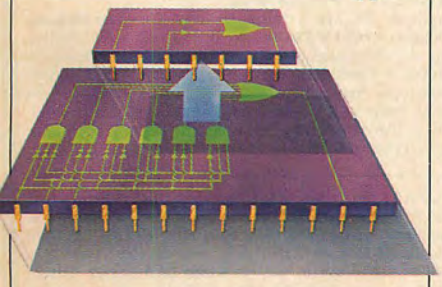

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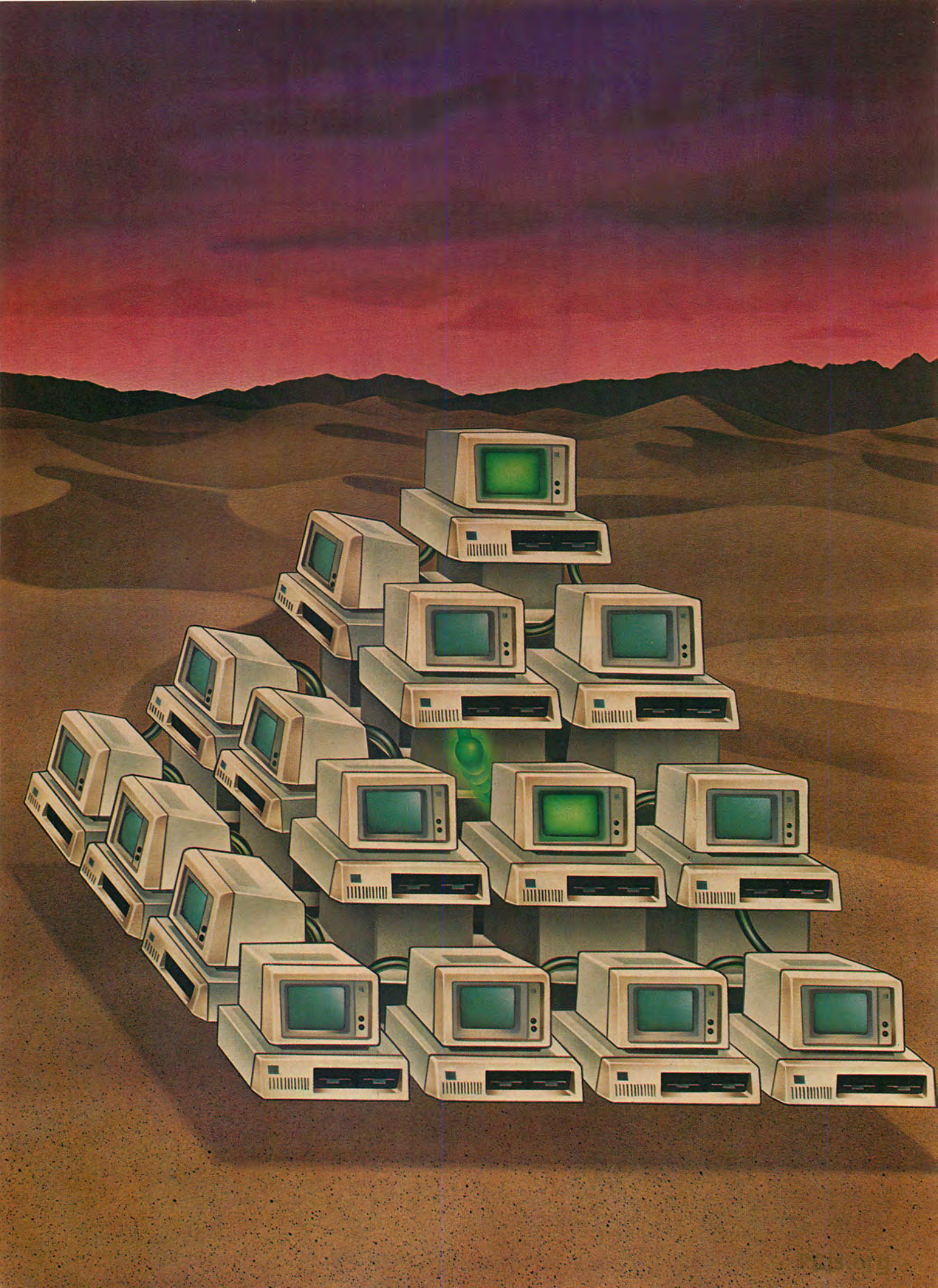

BRUCE W. CHURCHILL

PLAN 4000

AN OVERVIEW OF A TOKEN-PASSING LOCAL AREA NETWORK FOR THE IBM PC

In the previous two articles in this series I discussed local area networks that were based on "contention" access control. These systems used Carrier Sense Multiple Access technology to accommodate a large number of users contending for shared network resources, such as printers and mass storage devices. PLAN 4000 has a somewhat different approach to arbitrating access to the shared devices. You will notice, however, that many aspects common to all local area networks are featured in PLAN 4000, despite the different communications technology employed in this network.

OVERVIEW

PLAN stands for Personal Local Area Network, an appropriate acronym, since PLAN 4000 connects IBM PCs, Apple IIs, and Apple IIIs. PLAN 4000 has a distributed-star physical topology and is classified as a baseband, logical-ring network, with token-passing access control. In the two networks I reviewed previously, PCnet and EtherSeries, the topology was straightforward: they were distributed-bus systems with a single cable and workstation and server taps at prescribed intervals. A distributed-star topology is somewhat more complex to visualize, but at the same time it permits more flexible installations than does a distributed bus. It is important to keep in mind the distinction between physical and local topologies: the physical distributed-star topology of PLAN 4000 does not have the inherent disadvantages of a typical star network. This combination of topology and access control gives PLAN 4000 an architecture that behaves logically much like a distributed bus.

PLAN 4000 operates at a data rate of 2.5 megabits per second and will support multiple network segments. The data-path media for the network is RG-62 coaxial cable and standard BNC connector hardware. Each network segment supports up to 255 workstations and servers. Maximum cable distance between any two stations on a network segment is 4 miles. Special network components, known as Line Isolation Devices (LIDs), permit clusters of workstations to be separated by as much as 2,000 feet. Individual workstations or servers connected to a LID may be up to 2,000 feet from that LID. A 4-mile-long network would contain 22 intervening LIDs. The LIDs give PLAN 4000 its distributed-star physical topology. Figure 1 shows a typical PLAN 4000 network with workstations, servers, and LIDs, illustrating the distributed-star topology. Servers available for PLAN 4000 include file servers, file-transfer servers, print servers, and 3270 emulator servers. Operating systems supported are PC DOS and UCSD p-System for the IBM PC; DOS, CP/M, and Apple Pascal for the Apple II; and SOS for the Apple III. Electronic mail software is available as an application for the network environment.

Bruce W. Churchill is a captain in the U.S. Navy. He has written two other reviews of local area networks for PC Tech Journal *(see September/October and November/December issues).*

JOHN HAMAGAMI

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Figure 1: PLAN 4000 Local Area Network

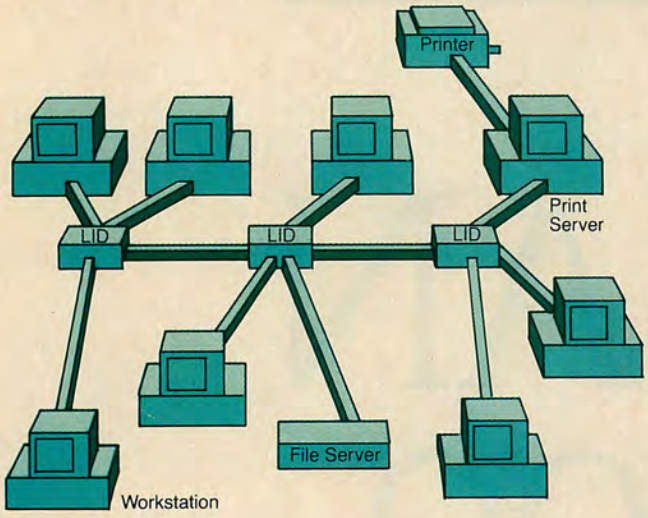
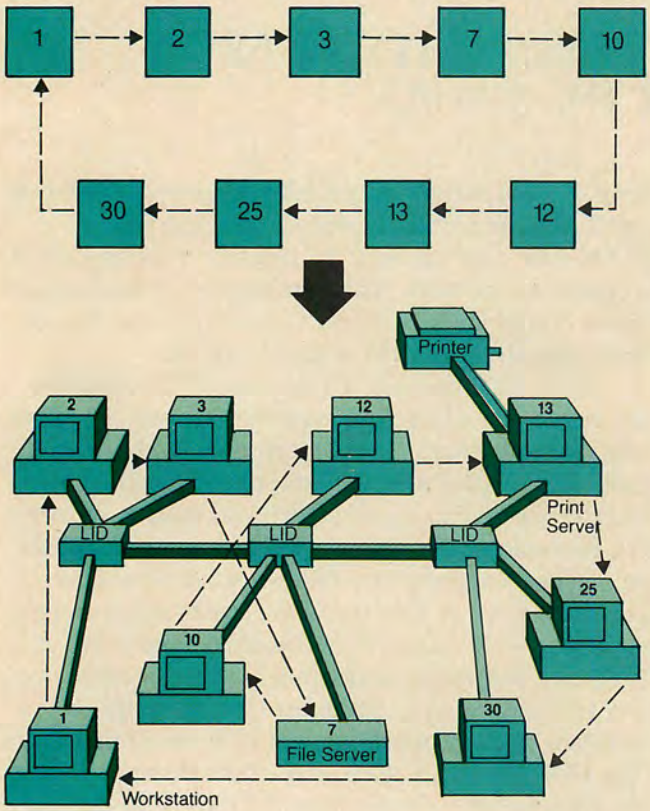


Figure 2: Logical Ring Structure of PLAN 4000



HARDWARE COMPONENTS

Plan 4000's component hardware features include network interface cards, Line Isolation Devices, cable media, file servers, file-transfer servers, print servers, and emulator servers. The system's physical topology can be configured in numerous different ways. Readers familiar with the Datapoint Arcnet system may realize that network interface cards, LIDs, and the cable media are based on the Arcnet local area network design. The same is true for the token-passing access scheme.

Network Interface Cards. Network interface cards are required in each workstation and server on the network. They are equivalent to Arcnet resource interface modules, which are used in both Datapoint and Radio Shack local area networks. The card has both an 8-bit station address selector for use in a single network segment and a unique 48-bit Ethernet address that allows internet operations using the Xerox Network Service (XNS) protocol. With appropriate internet addressing and multiple network interface cards, a single device may operate on more than one network segment.

The network interface card implements the Arcnet layer 1 and layer 2 protocols through a custom 3-chip set on the card. It supports a network speed of 2.5 megabits per second and a PC RAM-to-network buffer transfer speed of 381 Kbytes per second. The card contains 2 K of RAM for buffers, 2 K of RAM for programming, and 4 K of ROM. Physically, the card is a standard IBM PC expansion card, with one BNC-type connector on the rear faceplate. The network interface card may be plugged into any slot on the PC or XT expansion bus.

Line Isolation Device (LID). The LID corresponds to an active hub in the Arcnet system. Its functions are: to condition signals going from nodes to the rest of the network; to electrically isolate workstations and other devices from the rest of the network; to terminate the cable segments; and to route the signals in up to 10, 20, or 30 multiple directions. The isolation feature is particularly significant because it prevents line noise due to multiple taps; such noise is generally found in a distributed-bus network. There are no direct cable taps in the PLAN 4000 network. Signal routing is accomplished by the inclusion of 10, 20, or 30 multiple connection ports. A 30-port LID is contained within the file server, allowing it to function as a network hub for up to 29 devices, thus increasing the flexibility of system configuration.

Transmission Media. Network signals are transmitted through RG-62 coaxial cable, an inexpensive cable similar in size to the more familiar RG-59/U, which is used in radio communications systems. Connecting hardware is the same BNC-type used in the two networks discussed previously in this series. This is the same cable used with IBM-3270 terminal systems and with the Datapoint Arcnet system. As previously mentioned, PLAN 4000 does not allow or require direct taps

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into the network cable. All connections are made through LIDs or network interface cards. Maximum cable run between any two termination devices (network interface card, LID, or File Server) is 2,000 feet.

File Servers. A file server gives the PLAN 4000 network its real power in distributed processing applications. This device is a proprietary server that uses an 8-megahertz MC68000 and 256 Kbytes of RAM as its self-contained data processor. The server supports up to four 60- or 137-Mbyte formatted hard-disk drives and up to four 20- or 45-Mbyte streaming tape-cartridge drives for backup purposes. The network may be configured with multiple servers, allowing significantly large amounts of shared storage. The server contains a 29-port LID capability, the standard network interface card, and a clock-calendar card. The built-in LIDs allow the user to establish special-purpose subnetworks through the use of devices directly connected to the system.

File servers contain a resident volume-management program, which bears a distinct resemblance to IBM PC DOS 2.0 and its file management system. The volume management program orchestrates the establishment of variable-size and logical volumes and, in conjunction with software on user stations, handles backup, password protection, access control, error checking, and retransmission. The volume-management software is controlled through an attached local console or terminal, which communicates with the server at 9,600 baud. Additionally, control can be exercised from a remote console location through an attached modem. This method uses the dial-up phone system and communicates at 1,200 baud.

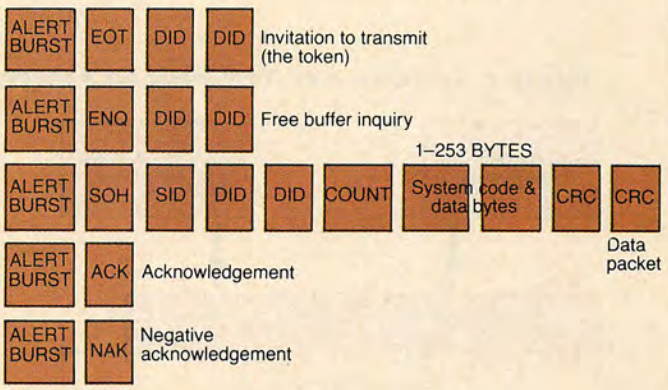
Print Servers. Print servers are workstations with appropriate printer and network-interface cards and a software package that runs both on the server and on individual user workstations. The hardware package consists of either a dedicated Apple II with 64K RAM and a network-interface card or an IBM PC with 128K RAM and a network-interface card. Multiple print servers may be attached to the network. Each server can support up to six printers if the appropriate printer adapter cards are provided. As with other network devices, a single print server may operate on more than one network segment, allowing physical centralization of printer resources.

The installed software package interacts with a designated file server to print user files according to parameters requested by the user. For example, there are four priorities for printing files: high, standard, low, and overnight. The print server may request up to eight files at the same time from a volume on the file server. Up to 999 multiple copies can be printed from a single request. The user completes a print-request form on his or her workstation to set up the required print jobs. This form is sent to the file server and stored as a "mini volume." The print server queries the file server approximately once every minute to check for outstanding print re-

Plan

4000 DOES NOT ALLOW OR REQUIRE DIRECT TAPS INTO THE NETWORK CABLE. ALL CONNECTIONS ARE MADE THROUGH LIDs OR NETWORK INTERFACE CARDS.

Figure 3: Arcnet Message Structure



ALERT BURST = 6 intervals of mark
EOT = ASCII end of transmission
DID = Destination ID
SID = Source ID
ENQ = ASCII enquiry
SOH = ASCII start of header
COUNT = Number of data bytes
CRC = Cyclic redundancy check
ACK = ASCII acknowledge
NAK = ASCII negative acknowledge

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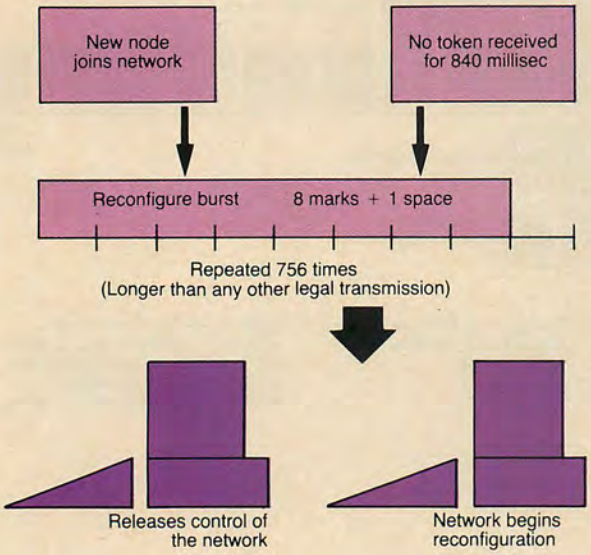
CSMA IS BASICALLY A STATISTICAL ALGORITHM, WHICH MEANS THAT WE CAN PREDICT NEITHER HOW MANY COLLISIONS WILL OCCUR OVER TIME NOR HOW LONG IT WILL TAKE THE NETWORK TO RECOVER FROM COLLISIONS.

Figure 4: Activation of New Node on Arcnet



quests. Once the user completes a print request, he or she will have no further interaction with the print server until notified that the job is complete.

File-Transfer Servers. These servers allow files to be transferred between two or more file servers on the same network segment, between file servers on dissimilar network segments, and between file servers on remote networks. Hardware consists of either the Apple II with 64K RAM or the Apple III with 128K RAM, network interface cards, and appropriate modems. Modems suitable for the Apple II are D.C. Hayes Micromodem II®, Owl Ltd. Owlmodem®, and the Novation Apple-CAT II®. The D.C. Hayes Smartmodem series is used for the Apple III version of the server.

If the server transfers files only within the same or a connected network segment, a modem is not required. A clock/calendar card is required in order to allow unattended and time-sequenced file transfers. In a network configuration, the file server provides the clock/calendar capability. This particular feature is one of the more useful aspects of the PLAN 4000 file-server concept. If the network users so desire, the file-transfer server can operate totally automatically, running a preset schedule of file-transfer events. I will discuss this feature in more detail later in this review. Alternatively, the file-transfer server may revert to a normal network workstation if the server capabilities are not needed. The server maintains a log of all its activities and uses its own command language, consisting of some thirty-four keywords. It is fully compatible with and supports the Nestar MESSENGER electronic mail software package.

IBM 3270 Emulator Server. The IBM 3278 Emulator Server allows up to sixteen workstations on the PLAN 4000 network to function as IBM 3270 display stations. The server communicates with mainframe computers that support the 3270 bisynchronous protocol. In essence, the server appears as an IBM 3274 Cluster Controller to the mainframe. User stations can be any combination of Apple IIs, Apple IIIs, and IBM PCs. Also required for the server is a high-speed modem, which, if the appropriate leased telephone lines are available, allows communications at speeds up to 9,600 baud.

THE TOKEN-PASSING PROTOCOL: HOW IT WORKS

Needless to say, there are vocal supporters both for contention systems, such as CSMA/CD, and for token-passing systems, such as PLAN 4000 and Arcnet. The following simplified description of the token-passing protocol points out, without editorializing, the major ways in which this protocol differs from the CSMA systems surveyed in the previous two articles.

Perhaps the major difference between the two technologies is that CSMA (with or without collision detect) is basically a statistical algorithm, which means that we

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can predict with certainty neither how many collisions will occur over time nor how long it will take the network to recover from collisions. Token-passing, on the other hand, is a very predictable method of controlling network access. A short, structured message, known as the *token*, is passed from station to station at regular intervals, the sequence of stations being determined by the logical structure of the network. A typical logical structure—one that corresponds to the physical network shown in figure 1—is shown in figure 2.

This token-passing protocol has several unique features:

1. Each node remembers the address of the node to which it last passed the token; in effect, the network maintains a list of active nodes dispersed throughout the network.
2. The protocol supports a broadcast mode in which messages are sent to all nodes without acknowledgement.
3. All transmissions except broadcasts must be acknowledged.
4. A message called the *free buffer enquiry* is sent prior to any data packets to verify that there is space available for data in the receiving node's buffer.
5. Only a single path may connect any two nodes.
6. The signal-passage time between any two nodes may not exceed 31 microseconds.
7. The protocol can be implemented on a variety of baseband or broadband modulation systems.
8. The protocol supports five types of messages (see figure 3). Each message is preceded by an *alert* burst that signals activity on the bus.
9. The basic information entity is an 11-bit sequence consisting of an 8-bit character preceded by two marks and a space.

The Arcnet protocol differs from CSMA-type protocols in that it manages reconfiguration in a predictable manner: reconfiguration results from a node entering or leaving the network. The system also describes any other event that causes the token to be destroyed, such as excessive line noise. In simple terms, if a node leaves the network, that node will not respond to an attempt to pass the token to it; the sending node waits 74 microseconds for a response and then increments its "next ID" counter, sending the token to the next node.

The network response when a node enters is somewhat more complex. Figures 4 and 5 show the sequence that occurs when a new node joins and how the network reconfigures after such a juncture. Contrast this behavior with a CSMA-type network, in which a node desiring to enter need only listen for a no-carrier condition on the bus before transmitting. The average time for a new node to enter a network cannot be predicted with certainty for a busy CSMA network.

One final aspect of the Arcnet protocol that deserves

Figure 5: Arcnet Reconfiguration

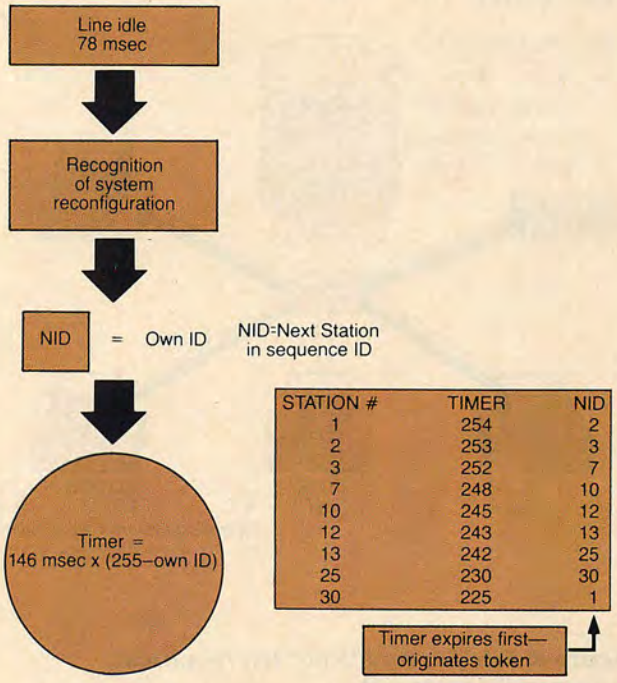

Figure 6: Interaction of PLAN 4000 and Host Processor

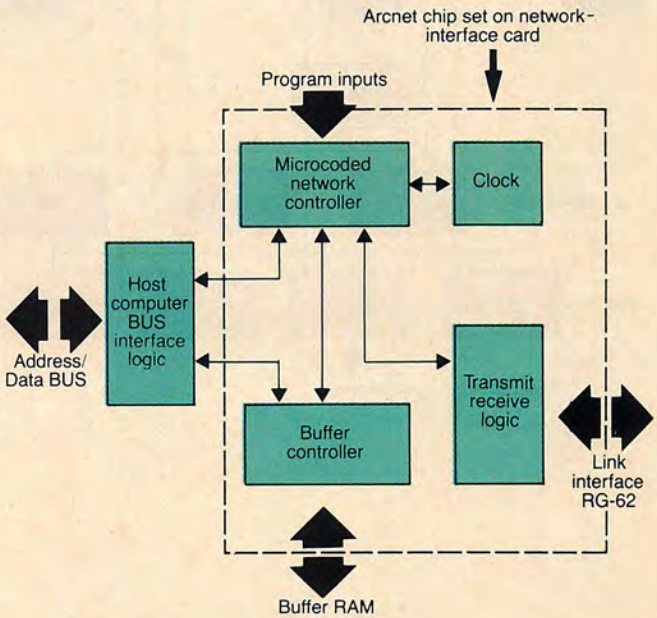

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Figure 7: PLAN 4000 File Server/Network Organization

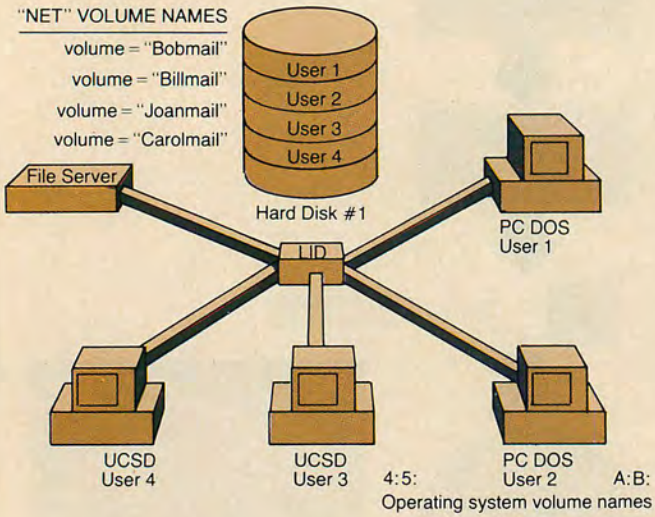
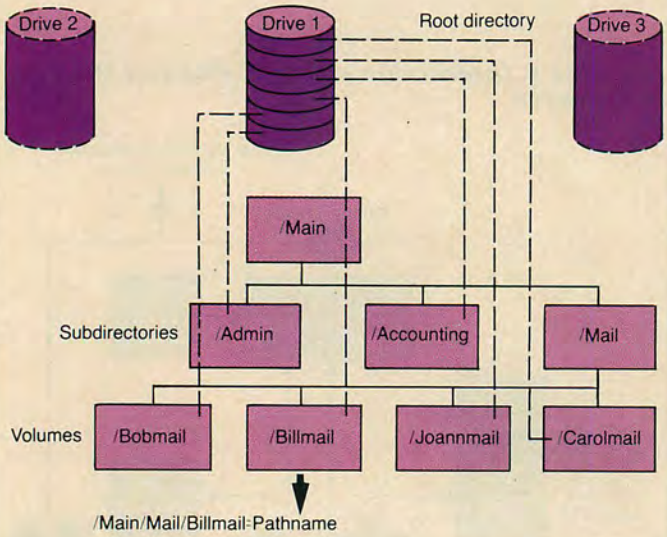


Figure 8: File Server/"Net" Hierarchical Volumes/Directories



comment is the processor/network interaction. The processor is concerned only with transmitting and receiving data packets; it is not involved in the details of token passing. This functional separation is shown in figure 6.

NESTAR PLAN 4000 SOFTWARE AND NETWORK OPERATION

As in most microcomputer installations, the real interest of local area network users lies not in the hardware or communications technology but in the software and applications that are available for a specific network. PLAN 4000 is well endowed with software that makes the network a truly useful tool. This software includes a high-level network operating system that manages file-server operations, specialized software that operates the various attached servers (other than file servers), and an electronic-mail software package. The essential features of these software packages are as follows:

NET Software. File-server management is provided by internal software that runs on the file-server MC68000 processor and by a series of files, collectively known as NET software, executed on each workstation. Briefly, the NET program at each workstation allows its user to:

1. create volumes on the file server hard disks
2. access these volumes by "mounting" them on virtual drives
3. otherwise share and control access to hard-disk space

The NET program is a high-level user interface to the file-server software. It does for hard-disk drive management what the host operating system does for individual files on a hard disk. The structure of NET hard-disk management closely resembles the hierarchical file structure of PC DOS 2.0, but NET is not otherwise related to that specific DOS. NET programs are designed to work in the following six environments if the appropriate modifications are made to the host operating system:

1. IBM PC DOS
2. IBM PC UCSD p-System
3. Apple II DOS
4. Apple II CP/M
5. Apple II Pascal
6. Apple III SOS

In this review, I will focus on the operation and features of the NET software as seen by a workstation user and the general capabilities of file-server internal software.

Some basic terminology and information about organizational relationships are provided in figures 7 and 8. Figure 7 illustrates the logical subdivision of the file server and its relationship to individual workstations with their host operating systems. Figure 8 shows a hierarchical volume organization that might exist on the network that is shown in figure 7.

A potential source of confusion with this network is the possible dual naming of hard-disk sectors on the file

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server. In the NET environment, these sectors are known as volumes or "virtual diskettes" and have a hierarchical file structure of volume names. On the operating-system level, the same segments of the hard disk are considered to be diskette drives of appropriate size and are referred to by the usual drive designators (A:, B:, C:, etc. for IBM PC DOS). It is not inconceivable that a user might work on the NET level to create and control access to volumes on the file-server hard-disk drives; the same user would then access individual files on that volume by the usual DOS file-level commands.

The term *mount* refers to the process of making a specific volume, or "virtual diskette," accessible by a user's DOS. In this sense, "mounting" is equivalent to inserting a diskette into a physical drive. "Unmounting" is just the opposite—removing a volume from access by the user's DOS. A volume must be mounted by NET before its files can be manipulated by the host DOS.

Commands to control the file server fall into six general groups:

1. Commands concerned with creating, deleting, naming and protecting virtual diskettes on the hard disk
2. Commands concerned with mounting virtual diskettes at a workstation
3. Commands associated with binary virtual volumes
4. Commands concerned with file locking
5. Commands that set default values for designating pathnames
6. Commands that give information at the terminal

The fundamental element of most of these commands is the "pathname." Pathname usage is almost identical to the syntax used in IBM PC DOS 2.0. The general structure of a NET pathname is

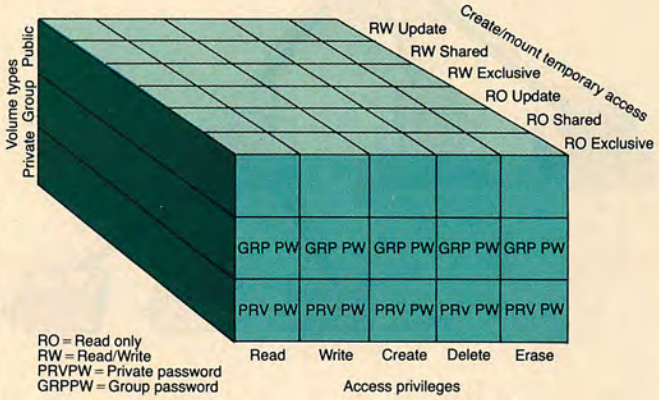
/diskname(rootdirectory)/subdirectory/ subdirectory/. . ./volume

Any part of the pathname, up to and including the last subdirectory, may be made a default pathname to reduce input required during NET operations. In a NET pathname, elements are directories and volumes; in a DOS 2.0 pathname, elements are directories and files.

When a volume is CREATEd on a hard disk, it is given a name and assigned to a specific directory. Its size can vary within the limits allowed by the host operating system. The host system is also specified by the CREATE process. Perhaps the most significant parameters in the CREATE process are the protection and access levels assigned to a particular volume. A volume can be PUBlic, allowing any user to access without passwords; GRouP, allowing access with group passwords; or PRiVate, allowing access only by use of a private password. Passwords are encrypted and cannot be recovered by debug procedures. For each of the volume types, there is a choice of any combination of READ, WRITE, CREATE, DELETE, or ERASE privileges. DELETE removes an en-

The NET PROGRAM IS A HIGH-LEVEL USER INTERFACE TO THE FILE-SERVER SOFTWARE. IT DOES THE SAME JOB FOR HARD-DISK DRIVE MANAGEMENT THAT THE HOST OPERATING SYSTEM DOES FOR INDIVIDUAL FILES ON A HARD DISK.

Figure 9: PLAN 4000 Protection Features



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The TYPE OF VOLUME (PUBLIC, GROUP, OR PRIVATE) AND ITS ACCESS PRIVILEGES (READ, WRITE, CREATE, DELETE, ERASE) DEFINE A MATRIX OF PERMANENT VOLUME-PROTECTION CHARACTERISTICS.

Figure 10a: Print-Server Options. One File Server Services Three Print Servers.

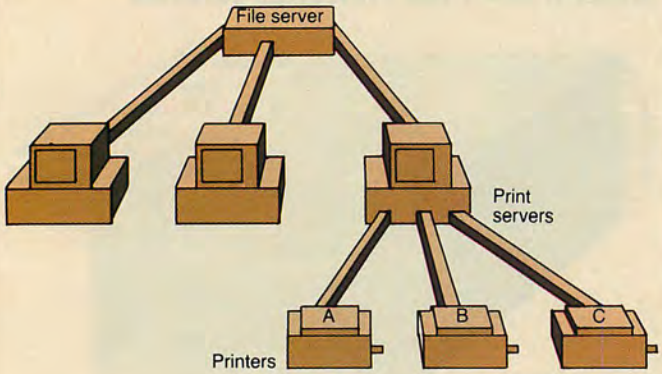
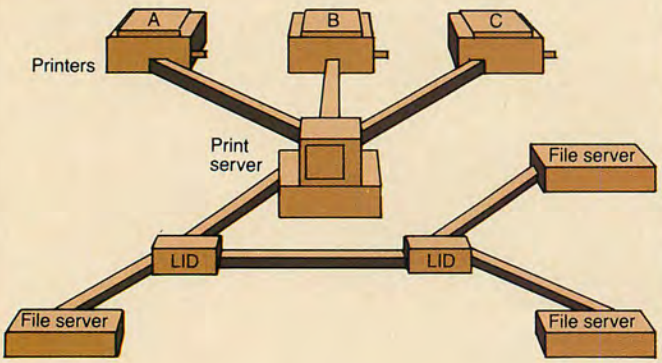


Figure 10b: Print-Server Options. One Print Server Configured for Three File Servers.



try from the directory, whereas ERASE removes the volume completely from the hard disk.

The type of volume (PUBlic, GRouP, or PRiVate) and its access privileges (READ, WRITE, CREATE, DELETE, ERASE) define a matrix of permanent volume-protection characteristics. These are in effect as long as the volume remains allocated on the hard disk. In addition, temporary usage levels are superimposed on the permanent matrix. When a volume is CREATEd or MOUNTed, the temporary access restrictions may be invoked if the user desires. Temporary access may be either READ ONLY or READ/WRITE; each of these may have a choice of SHaRed, EXClusive, or UPDate usage. For example, a volume mounted by one user with READ/WRITE, UPDate temporary protection may be accessed by other users with a READ ONLY, SHaRed privilege. Other combinations provide a range of temporary protection levels to the user.

A third form of protection exists at the resource level, which includes files and I/O devices. This protection, called a *lock*, is cooperative in that applications programs or DOS batch files must honor the access protection. Locks can be set on a file or on an I/O device such as a printer for either EXClusive or SHaRed use, depending on whether more than one user can set the lock on a shared resource. Locks are controlled at the command level of DOS. Protection features offered by PLAN 4000 are summarized in figure 9.

File-Server Utility Operations. The file server itself has software that is controlled from a console terminal at the server. The general capabilities of file-server software are utilitarian in nature and include the following functions:

1. partial tape dump/restore
2. full tape dump/restore
3. copy partial or full disk to disk
4. list disk contents
5. examine/modify disk contents
6. check disk consistency
7. format and repair disks
8. modem on/off
9. add/modify tape dump instruction files
10. edit file server startup file

These capabilities are usually run from the attached console but can also be run from a remote console through a modem port on the file server. My discussion of these capabilities will be limited to the tape backup features and their associated instruction files.

Both partial- and full-tape dump options use a 45 megabyte, ¼" tape cartridge, integral to the file server unit. The partial dump requires thirty to ninety minutes to back up a 60-megabyte hard disk; the full dump takes twelve minutes to fill a 45-megabyte cartridge and eighteen minutes to complete a 60-Megabyte backup. Options available for partial backups include:

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1. save volumes by modification date criteria
2. purge volumes by last read/write date criteria
3. save and/or restore selected volumes
4. save and/or restore selected volumes under specified directories

Tape-dump instruction files can be created to automatically execute frequently performed tasks. Up to eight of these are allowed, and five of them can be preset on system delivery. Some examples of canned operations include daily backup, archive/purge, software distribution, large-volume interchange, and disk compaction. These operations may be modified or others created. The task of backing up system disks is best left to an individual designated as the system manager, because in most organizations data integrity is too critical to be put in the hands of all network users.

Print-Server Operation. The print server is an Apple II or IBM PC workstation with added I/O cards to handle printers and the software required to interact with one or more file servers. The print server also requires one or more network interface cards, depending on the number of network segments to be serviced. When a network printing service is established, there are several options available for print-server topology. Three of these are illustrated in figures 10a, 10b, and 10c. Each of these options requires appropriate setup within network software. The initiation and maintenance of print-server configuration files is another job appropriate for a system manager, who would be responsible for:

1. creating and maintaining configuration files that tell the print server(s) what options are desired—network segments to be serviced, file servers to query for print files, connected printers and their setups, and so on
2. maintaining print job queues, including the purging of invalid print requests
3. presetting desired defaults in print request forms

The print server operates on a priority-queued basis with multiple printers and provides the intelligence to interact with a specified file server or servers. This interaction allows files to be printed in order of priority and with other user-desired options. The interaction between the print server, file server(s), and user workstations is shown in figure 11.

Exact user interface is determined by the host operating system, but the general options available are shown in table 1, which includes a brief explanation of what each option provides. Once these options are selected, the print-request file is created and sent to the appropriate file server as a "mini-volume." Print-request volumes are listed under a special directory on the file server. The file server is interrogated periodically by the print server to determine what print-request files exist and what their proper execution sequence is. Once a job is begun on a specific printer, it is completed, even if

Figure 10c: Print-Server Options. Different Network Segments from One Print Server

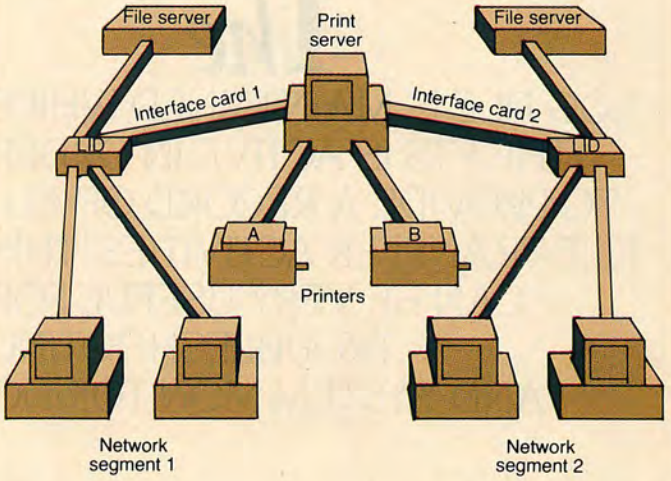
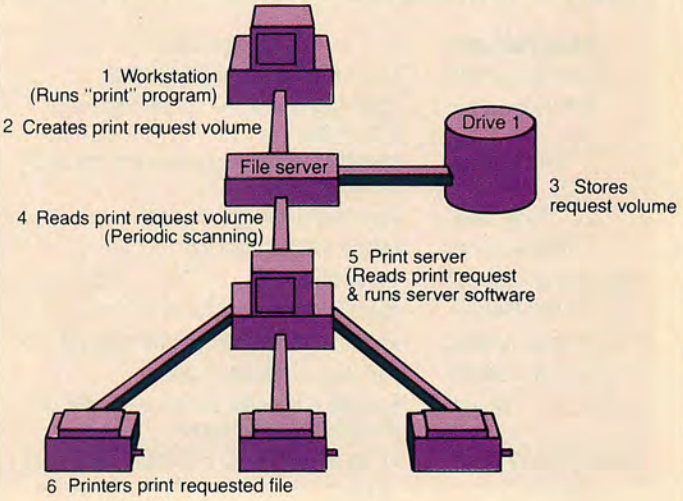


Figure 11: Print Server/File Server Interaction



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The LOG FILE IS MAINTAINED WHILE THE FTS IS ACTIVE IN ORDER TO PROVIDE A RECORD OF ALL FILE-TRANSFER ACTIVITIES. THIS CAN BE VERY USEFUL FOR TROUBLESHOOTING AND SYSTEM MONITORING.

Table 1: Print-Request Options for Print Server

Print Request	Options
File(s) to print?	Up to 8 from a single volume
FS Pathname:	Identify the volume containing the print files
File Server:	Identify the server containing the print-file volume
Page Title:	Optional 5-line title header
Identification:	Name for the print job
Number of Copies:	Up to 999
Print Server:	Identify the desired print server
Printer Model:	Identify the specific printer desired
Eject (0 = none):	Number of lines per page
Setup:	Identify a specific printer setup file on the desired print server
Priority (L/S/H/O):	LOW/STANDARD/HIGH/OVERNIGHT

Table 2: FTS Command-File Keywords

ALWAYS	FILE	PASSWORD
AT	FOR....TIMES	RECEIVE
BEGIN	HOUR(S)	REPLACE
CONNECT TO SITE	ID	RETRY IN
DEFINE....AS	IS PHONE	SEND
DELETE	LIST	SET CHAIN
DIR	MINUTE(S)	SITE
DO	MYSITE	SLOT
END	NFS	STN
DO	MYSITE	SLOT
END	NFS	STN
EVERY	NOLIST	TO
EXIT	NOLOG	USES VOL

the printer gets new print requests with higher priority.

The File-Transfer Server. The File Transfer Server (FTS) is one of the unique and powerful features of PLAN 4000. Figures 12 through 15 illustrate the possible ways to accomplish file transfers.

To clarify the operation of the FTS, I will discuss a specific example of remote file transfer using the FTS command language. In order for a workstation to become a part-time or full-time FTS, it must run at least the FTS software. A connected modem is required for remote file transfers, and a network interface card is required for every network segment to be serviced. A clock/calendar card is required for the automatic features of the FTS command language; in a network environment, the file server contains the clock/calendar card.

The file-transfer server can transfer the following objects:

1. file-server volumes of all allowable operating systems
2. binary image volumes
3. text files (print-server spooled files, electronic mail)
4. file-server directories
5. Apple II Pascal and Apple III SOS files

Obvious omissions from this list are IBM PC DOS and UCSD p-System files; presumably these will be included when IBM PC FTS software becomes available.

FTS is designed to operate in a fully automatic mode, although that mode can be overridden by operator intervention, and the server can be reverted to a normal workstation function. The FTS software is written in Apple Pascal and uses two types of files: a log file and a command file. The log file is maintained while the FTS is active in order to provide a record of all file-transfer activities. This can be very useful for troubleshooting and system monitoring. The command file is the heart of the FTS system and will be described in further detail, including an example of usage.

The command file is read and compiled by the FTS software to generate a list of activities to be performed. Those operations to be carried out immediately are called *globals*; the remaining activities are time-scheduled and are called *procedures*. In command-file format, a procedure might look like

```
BEGIN Task 1
  SEND VOL /main/personnel/engineering, FILE
  roster; TO VOL /main/personnel/ship, FILE
  recall;
END
```

In this case, the procedure name is Task1. Once the procedure is defined it can be scheduled:

AT 0900 DO Task1

or

EVERY n HOURS DO Task1

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Table 2 lists the 34 allowable keywords used in command files. As you can see, the FTS capabilities are quite extensive. Once in automatic mode, FTS continually scans for operator interrupt via the [ESC] key and for incoming phone calls if a modem is attached. If the operator intervenes, the following menu is presented:

(C)ontinue (P)assword (Q)uit (S)chedule (R)estart

The (S)chedule option allows the operator to hand-schedule an FTS procedure.

Figure 16 shows a sample command file controlling the FTS at a home office and at two district offices. The file is set up with the procedures defined in the beginning, followed by the desired time sequencing. At 1:00 AM every morning, daily.text (a Pascal file) is moved from one volume to another on the home-office hard disk. At 3:00 AM every morning, the home office initiates a remote connection using the AT command line and the "calldistrict1" procedure. In order to start the transfer, the home-office FTS checks the "district1" IS PHONE and USES clauses to find out what phone number to dial and what modem mode to use.

"Home" calls "district1" using a 300-baud modem data rate. It then transfers the file daily.text on the volume /main/users/reports with an ID of "update." "District1" is set up to receive an object with the ID "update" and is otherwise compatible with modem and data rate. Once the transfer is completed, "district1" checks for a CONNECT TO SITE home command; since that command exists in "district1" 's command file, an object called "april" is transferred from "district1" to "home." At 4:00 AM every morning, "home" dials "district2," changing its modem rate to 1,200 baud to match that of "district2." The object called "update" is again sent, and "district2" sends the object called "payroll" to "home."

3270 Binary Synchronous Communications Emulator. The final PLAN 4000 subsystem to be described in this article is the 3270 Emulator Server and its associated workstations. In a typical IBM-mainframe remote-job entry application, a 3274 remote cluster controller is connected to the mainframe via modem and leased line or direct connection. The protocol used between the controller and the mainframe is binary synchronous. In such a system, some number of 3278 remote terminals is hardwired, using connection ports, to a single 3274. A combination of hardware cards and software allows one workstation to become a 3274 controller emulator and up to sixteen other workstations to become 3278 terminal emulators. The 3274 emulator uses a bisynchronous communications adapter card for connection to a modem or mainframe, a network interface card for PLAN 4000, and software to conduct bisync communications and to recognize other workstations as 3278 emulators. The 3274 emulator is also called the gateway

Figure 12: FTS Intranetwork Transfer

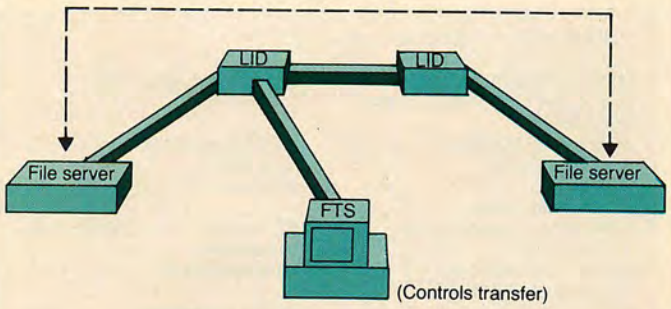

Figure 13: FTS Intersegment Network Transfer

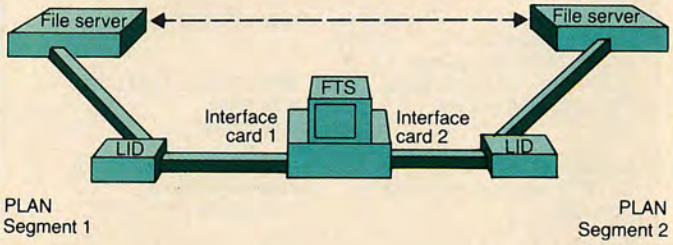

Figure 14: FTS Network-to-Network

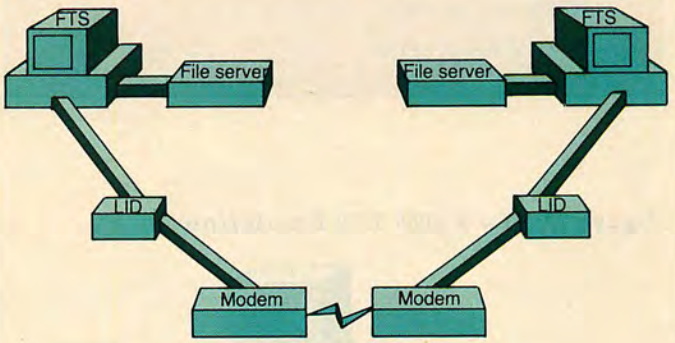

Figure 15: FTS Network-to-Standalone

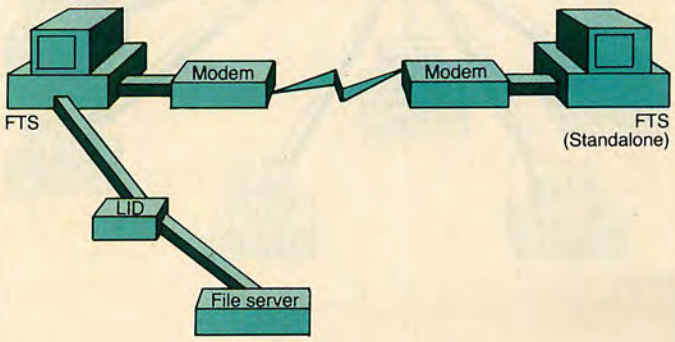

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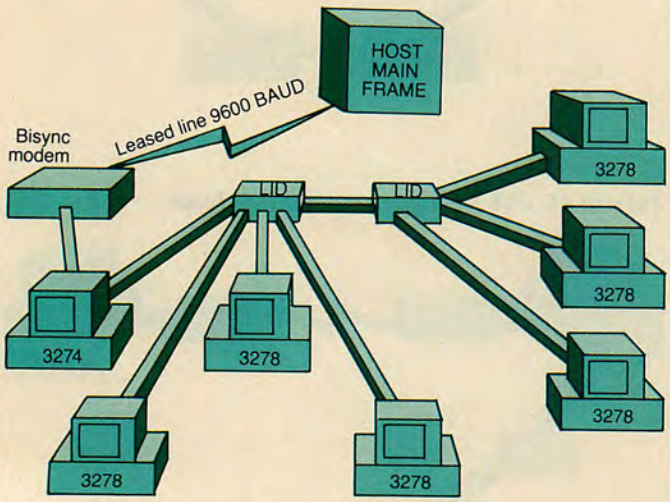
Figure 16: FTS Command File

```
HOME OFFICE COMMAND FILE

MYSITE home USES 1200;
SITE district1 IS PHONE 123-4567
USES 300;
SITE district2 IS PHONE (213) 522-
3333 USES 1200;

BEGIN createupdate;
SEND /main/users/bill/reports,
FILE daily, text;
TO /main/users/reports
FILE daily.text REPLACE;
END;

BEGIN calldistrict1;
CONNECT TO SITE district1
ALWAYS;
SEND VOL /main/users/reports
FILE daily.text ID update;
END;

BEGIN calldistrict2;
CONNECT TO SITE district2;
SEND VOL /main/users/reports
FILE daily.text ID update;
END;

RECEIVE ID april
TO VOL /main/account/expense/jim,
REPLACE;

RECEIVE ID payroll TO VOL /main/
finance
REPLACE;

AT 0100 DO createupdate;

AT 0300 DO calldistrict1, RETRY
IN 10 MINUTES FOR 5 TIMES;

AT 0400 DO calldistrict2, RETRY
IN 10 MINUTES FOR 5 TIMES;

District 1's Command File:

MYSITE district1 USES 300;
SITE home;
SITE district2;

RECEIVE ID update TO VOL main/
home/reports
FILE daily.text REPLACE;

BEGIN answerhome;
CONNECT TO SITE home;
SEND VOL /main/expense/jim, ID
april;
END;

District 2's Command File:

MYSITE district2 USES 1200;
SITE home;
SITE district1;

RECEIVE ID update TO VOL
/main/home/reports
FILE daily.text REPLACE;

BEGIN answerhome;
CONNECT TO SITE HOME;
SEND VOL /main/users/lynne,
ID payroll;
END;
```

Figure 17: PLAN 4000 3270 Emulation



station, as it connects two dissimilar network protocols.

The emulators run in the UCSD p-System environment, which the system manager (a very busy person!) can set up to boot automatically for a 3278 emulator user. More than one 3278 emulator can share a virtual 3274 port on the gateway; software prevents conflicts on shared ports and allows the use of optional passwords to control access to the gateway. Software on the 3278 emulators allows users to set up keyboard sequences and display to emulate those of the 3278. Interaction with the host mainframe is identical to that used by the actual 3278. The 3278 emulator station can terminate the 3278 connection to the gateway by menu action, thus reverting to a normal network workstation. A typical 3270 emulation configuration existing on PLAN 4000 is shown in figure 17.

EVALUATION

I think it is clear that PLAN 4000 has taken a big step toward bringing maturity to the IBM PC local networking market. The variety of servers and network-support software, combined with a full spectrum of topological possibilities, makes this a powerful communications tool for a business or corporate entity. The major drawback of PLAN 4000—its high initial cost—will be addressed with PLAN 3000, which will use a lower-cost dedicated file server, and PLAN 2000, which will use IBM PC-XTs as servers. Applications software, currently represented by the Messenger electronic-mail system, is of high quality but is in short supply. This is an industry shortcoming that is already improving. PLAN 4000 will be a viable force in the IBM PC local area network picture for the foreseeable future.

Companies mentioned in this article:

HAYES MICROCOMPUTER PRODUCTS, INC.
5923 Peachtree Industrial Blvd.
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404-449-8791
CIRCLE 462 ON READER SERVICE CARD

NESTAR SYSTEMS, INC.
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Palo Alto, CA 94303
415-493-2223
CIRCLE 463 ON READER SERVICE CARD

NOVATION, INC.
20409 Prairie St.
Box 2875
Chatsworth, CA 91311
800-423-5419 or (in California) 213-996-5060
CIRCLE 464 ON READER SERVICE CARD

OWL ASSOCIATES
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303-245-2303
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